HEAT SPECTRA

I NOTICE in NATURE, vol. i., p. 28, an account of some very important researches on Heat Spectra, made by the late Professor Magnus; and I am gratified to think that some observations which I made on the subject in the years 1858 and 1859 were confirmed by this eminent German philosopher.

In a paper read before the Royal Society of Edinburgh in 1858, I showed that rock-salt absorbs heat radiated from rock-salt in larger quantity and more powerfully than other kinds of heat; and also that the amount of absorption of rock-salt for heat increases with the thickness of the absorbing plate. These are the fourth and fifth results of Professor Magnus. His next result is very interesting, namely, that the high diathermancy of rock-salt does not depend on its small absorptive power for the different kinds of heat, but on the fact that it only radiates, and consequently only absorbs, heat of one kind; while almost all other bodies at the temperature of 150° F., emit heat which contains only a small fraction or none of those rays which are given out by rock-salt.

Certain experiments which I made in 1859 lead me to think that Professor Magnus was quite justified in his conclusion that the heat radiated and absorbed by rock-salt is a peculiar kind of heat. These experiments, which are described in the Transactions of the Royal Society of Edinburgh, are as follows. I tested the quality of the heat radiated by rock-salt at 212° F. by transmitting it through three different screens:—

α A screen of mica.
β One of mica split by heat.
γ One of glass.

It was found that a mica screen, which passed about 31 per cent. of ordinary lampblack heat, passed only 18 per cent. of rock-salt heat; or if we call the proportion of black heat passed by the mica 100, that of rock-salt heat will be 58. Again, it was found that while 20 per cent. of lampblack heat passed through a screen of split mica, the proportion of rock-salt heat transmitted through the same screen was only 15¼ per cent. These numbers are to one another as 100 to 76.

Lastly, with respect to a glass screen, calling the proportion of lampblack heat which passed 100, that of the rock-salt heat which passed the same screen was 57.

On these results I remark as follows:—It is already well known that rays of great refrangibility, or small wave length, pass through glass or mica more readily than those of an opposite character. The difficulty with which rock-salt heat penetrates these substances as compared with ordinary heat, might therefore lead us to infer that the wave length of this heat is greater than that of ordinary lampblack heat.

If we now look to the relative transmission of the two descriptions of heat through mica split by heat, we see that the facility of transmission is yet in favour of ordinary heat, but not so strikingly as with a screen of common mica. This will be seen from the following table:—

Nature of Screen	Transmission of Ordinary Heat at 212°	Transmission of Rock-salt Heat at 212°
Mica	100	58
Mica split by heat	100	76

Compare this with the following table, deduced from the results given by Professor Forbes:—

Nature of Screen	Transmission of Heat from Blackened Brass at 700° F.	Transmission of Black Heat at 212° F.
Mica ·015 inch thick	100	52
Mica split by heat	100	64

From a comparison of these two tables, it will be seen that, as tested by the two substances, mica and mica split by heat, rock-salt heat at 212° F. bears to ordinary heat of that temperature a relation similar to that which ordinary heat at 212° bears to heat at 700°; that is to say, that just as heat of 212° has a greater wave-length than heat of 700°, so rock-salt heat at 212° has a greater wave-length than ordinary heat at that temperature. And the *surface stoppage* produced by splitting the mica, telling most powerfully upon heat of high temperature, or small wave-length, while the *stoppage* by *substance* is in the opposite direction, we see how the one effect tends, to a certain extent, to neutralise the other, rendering the proportions of different kinds of heat passed by split mica more nearly alike than those passed by ordinary mica. In connection with these remarks I may state that neither the radiation nor the absorption of a plate of rock-salt is sensibly influenced by roughening its surface with emery paper.

All these experiments concur in showing that heat from rock-salt possesses very great wave-length, and probably heat from a thin plate of this substance, at a low temperature, may be found to possess a greater wave-length than any other description of heat which can be exhibited.

The observations of Professor Magnus with respect to the nature of the heat from potassium chloride are very interesting; unfortunately I did not make any experiments on this substance, but I did on some others in the shape of powder.

I found that the comparative radiation at 212° was as follows:—

From lamp black	100
Alum in powder	100
White sugar	98·7
Sulphate of potash	88·1
Nitrate of potash	86·7
Table salt	83·1

The experiments of Prof. Magnus on the reflection of heat are also of the very greatest importance, and they strengthen the evidence (already overwhelming) in favour of that view which regards light and heat as varieties of the same agent differing in nothing except wave-length.

BALFOUR STEWART

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*ON THE METHOD OF ASSAYING SILVER AS CONDUCTED IN THE INDIAN MINT**

BY DR. H. E. BUSTEED, OFFG. ASSAY MASTER

THE method of assaying silver, as now in use in H.M.'s Indian Mints, is one peculiar to them; it was introduced into the Calcutta Mint about the year 1850, and thence extended in course of time to those of Bombay and Madras.

It has been favourably reported on and described more or less in detail as an official duty by various assay officers to local Mint authorities in India; but beyond this it would appear that no attempt has been made towards giving publicity to the practical working of the process, or to making generally known the laboratory details of this method of assay.

It has been suggested to the writer that some such attempt now would be not only interesting but useful, as after twenty years' experience of it, the assay offices in the Indian Mint must be in a position to assign its true value to a method which has been used for the assay of an immense importation and coinage of silver bullion. To render it more generally intelligible, and to show wherein the process about to be explained contrasted with those in more general use, Dr. Busteed very briefly adverted to the principles on which those processes depend for their results, omitting details and technicalities. In modern acceptance, the principal duty of an assayer is to ascertain the proportion of the precious metals present in any sample of mixed metal submitted to him for examination, so that from the result of his investigation the proper value may be assigned by calculation to the mass which the sample is supposed to represent.

This the assayer effects by separation of the precious metals from the coarser ones. The most ancient means of effecting this was by the method of *cupellation*. He explained the principle of this method, what skill and experience it required on the part of the operator, and how it still fell short of accuracy in its results.

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* From the Proceedings of the Asiatic Society of Bengal.

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Its shortcomings led to the invention of another process by Gay-Lussac, known as the volumetric, or humid, method, which is much more accurate, and is now practised very generally on the Continent. Its principles were briefly glanced at. Its introduction, however, into the Indian Mints was not considered desirable by their assay officer for certain reasons, a few of which were given. The method of cupellation, therefore, being not accurate enough for the purposes of buying and selling bullion, and that by the French process being considered not well suited to Indian Mints, it became necessary to look out for and introduce into the Mints of this country a process more likely to answer all the ends in view.

This object was attained by the adaptation and introduction of the process now in use, viz. the "Chloride process of assaying silver.' Hitherto it had never been resorted to, except on a very small scale. Assayers appear to have shrunk from the manifest difficulties of manipulation in collecting, drying, and weighing the precipitated chloride of silver. The credit is due to Mr. James Dodd, a former Assay Master of the Calcutta Mint, of having so simplified, modified, and systematised the details of this method, as to render its application to the assaying of silver on a large scale easy and accurate. The principles, and an outline of the details of the process were then given, an understanding of some of the chief appliances and steps in the manipulations being assisted to by suitable photographs. The system of weights in use, and the quantity of the sample taken for assay, were also explained, as well as the points wherein this system might fairly be considered better suited to a Mint in India than the other methods.

In conclusion Dr. B. alluded to the vast amount of silver bullion which this process enabled the assay officers of the Indian Mints to deal with confidently and accurately during the past fifteen years. In one year alone, that of 1865-66, the importation of silver bullion reached to the immense amount of over fourteen millions sterling, so putting to a crucial test the system of assay used for its valuation.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 12.—"On Fluoride of Silver," Part II., by George Gore, F.R.S. An exhaustive account of the behaviour of argentic fluoride in vessels of platinum, carbon, and various fluorides in contact with chlorine, bromine, and iodine at various temperatures. When argentic fluoride is completely decomposed by chlorine in platinum vessels at a red heat, the reaction agrees with the following equation :—

$$4\,Ag\,F + 4\,Cl + Pt = 4\,A\,G\,Cl,\ Pt\,F_4.$$

Vessels of cryolite and of fluor-spar were found incable of retaining argentic fluoride in a melted state. Other vessels were also made by melting and casting various mixtures of earthy fluorides at a high temperature ; and although forming beautiful products, probably capable of technical uses, they were not capable of retaining silver fluoride in a state of fusion. Numerous vessels were also made of seventeen different fluorides by moulding them in the state of clay and baking them at suitable temperatures ; these also were found incapable of holding melted fluoride of silver. Argentic fluoride was only superficially decomposed by chlorine at 60° Fahr. during thirty-eight days. When heated to 230° Fahr. during fifteen days in a platinum vessel in chlorine, it was very little decomposed. Chloride of silver heated to fusion in a platinum vessel in chlorine corroded the vessel and formed a platinum-salt, as when fluoride of silver was employed. An aqueous solution of argentic fluoride agitated with chlorine evolved heat and set free oxygen, in accordance with the following equation :—

$$8\,Ag\,F + 8\,Cl + H_2O = 5\,Ag\,Cl + 3\,Ag\,Cl\,O + 8\,H\,F + O,$$

or

$$7\,Ag\,Cl + Ag\,Cl\,O_3 + 8\,H\,F + O.$$

Dry hydrochloric acid gas completely decomposed argentic fluoride in a melted state, but only acted upon it superficially at 60° Fahr. A saturated aqueous solution of argentic fluoride was not precipitated by chloric acid. Perfectly anhydrous fluoride of silver was only superficially decomposed by contact with bromine in a platinum vessel during thirty-six days at 60° Fahr., or during two days at 200° Fahr. At a low red heat in vessels of platinum argentic fluoride was completely decomposed by a current of bromine vapour, a portion of its fluorine being expelled and a portion corroding the platinum and forming an insoluble compound of fluoride of platinum and bromide of silver. In carbon boats at the same temperature the whole of the silver-salt was converted into bromide, the boat being corroded and the fluorine escaping in chemical union with the carbon. The action of bromine on an aqueous solution of argentic fluoride was similar to the action of chlorine. A solution of argentic fluoride yielded copious precipitates both with hydrobromic and bromic acids. Under the influence of a temperature of 200° to 600° Fahr. in closed platinum vessels, iodine very slowly and incompletely decomposes argentic fluoride without corroding the vessels, and produces a feeble compound of argentic iodide, fluorine, and iodine, from which the two latter substances are expelled at a red heat. At a red heat in platinum vessels, iodine produces argentic iodide, and in the presence of free argentic fluoride corrodes the vessels in consequence of formation of platinic fluoride ; iodine and fluorine pass away together during the reaction. In vessels of carbon at the same temperature, argentic iodide is formed, the vessels are corroded, and a gaseous compound of fluorine and carbon is produced. By treating an aqueous solution of argentic fluoride with iodine, similar results are produced as with bromine and chlorine ; a similar solution yields copious precipitates both with hydriodic and iodic acids. A mode of analysis of iodine is also fully described in the paper. A known weight of iodine was dissolved in absolute alcohol, a strong solution of argentic nitrate of known strength added to it in proportions at a time with stirring until the colour of iodine exactly disappeared. The mixture was evaporated, the free nitric acid expelled by careful heat, and the residue weighed. The residue was then heated to fusion to convert the iodate of silver into iodide, and again weighed. Two experiments of this kind yielded accurate results, and the process was easy and expeditious.

January 19.—"On the Structure and Development of the Skull of the Common Frog (*Rana temporaria*)," by W. Kitchen Parker, F.R.S. At the close of my last paper, "On the Skull of the Common Fowl," I spoke of bringing before the Royal Society another, treating of that of the osseous fish. I was working at the early conditions of the salmon's skull at the time. I was, however, led to devote my attention to another and more instructive type early in the following year ; for it was then (January 1869) that Professor Huxley was engaged in preparing his very important paper "On the Representatives of the Malleus and Incus in the other Vertebrata" (see Zool. Proc. May 27, 1869). In repeating some of his observations for my own instruction, it occurred to me to renew some researches I had been making from time to time on the frog and toad. The results were so interesting to us both, that it was agreed for me to work exhaustively at the development of the frog's skull before finishing the paper on that of the salmon. On this account Professor Huxley mentions in his paper (*op. cit.* p. 406) that he leaves the Amphibia out of his demonstration, and that they are to be worked out by me. The amount of metamorphosis demonstrable in the chick whilst enclosed in the egg, suggested a much more definite series of changes in a low, slow-growing Amphibian type. I think that this has been fully borne out by what is shown in the present paper.

The first of the ten stages into which I have artificially divided my subject is the unhatched embryo, whilst its head and tail project only moderately beyond the yelk-mass. Another stage is obtained by taking young tadpoles on about the third day after they have escaped from their glairy envelope ; a few days elapse between the second and third stages, but a much longer time between the third and fourth, for the fourth stage is the perfect tadpole, before the limbs appear and whilst it is essentially a fish with mixed Chimæroid and Myxinoid characters. Then the metamorphosing tadpole is followed until it is a complete and nimble frog, two stages of which are examined, and then old individuals are worked out, which give the culminating characters of the highest type of Amphibian.

The early stages were worked out principally from specimens hardened in a solution of chromic acid ; and the rich umber-brown colour of these preparations made them especially fit for examination by reflected light.

Without going further into detail as to the mode of working my subject out, and without any lengthened account of the results obtained, I may state that the following conclusions have been arrived at, namely, that the skull of the adult is highly compound, being composed of :—

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